Inter-Regional Travel Model Project

Jointly Undertaken by:

Mountainland Association of Governments,

Wasatch Front Regional Council,

Utah Transit Authority,

Utah Department of Transportation, and

Governor's Office of Planning and Budget

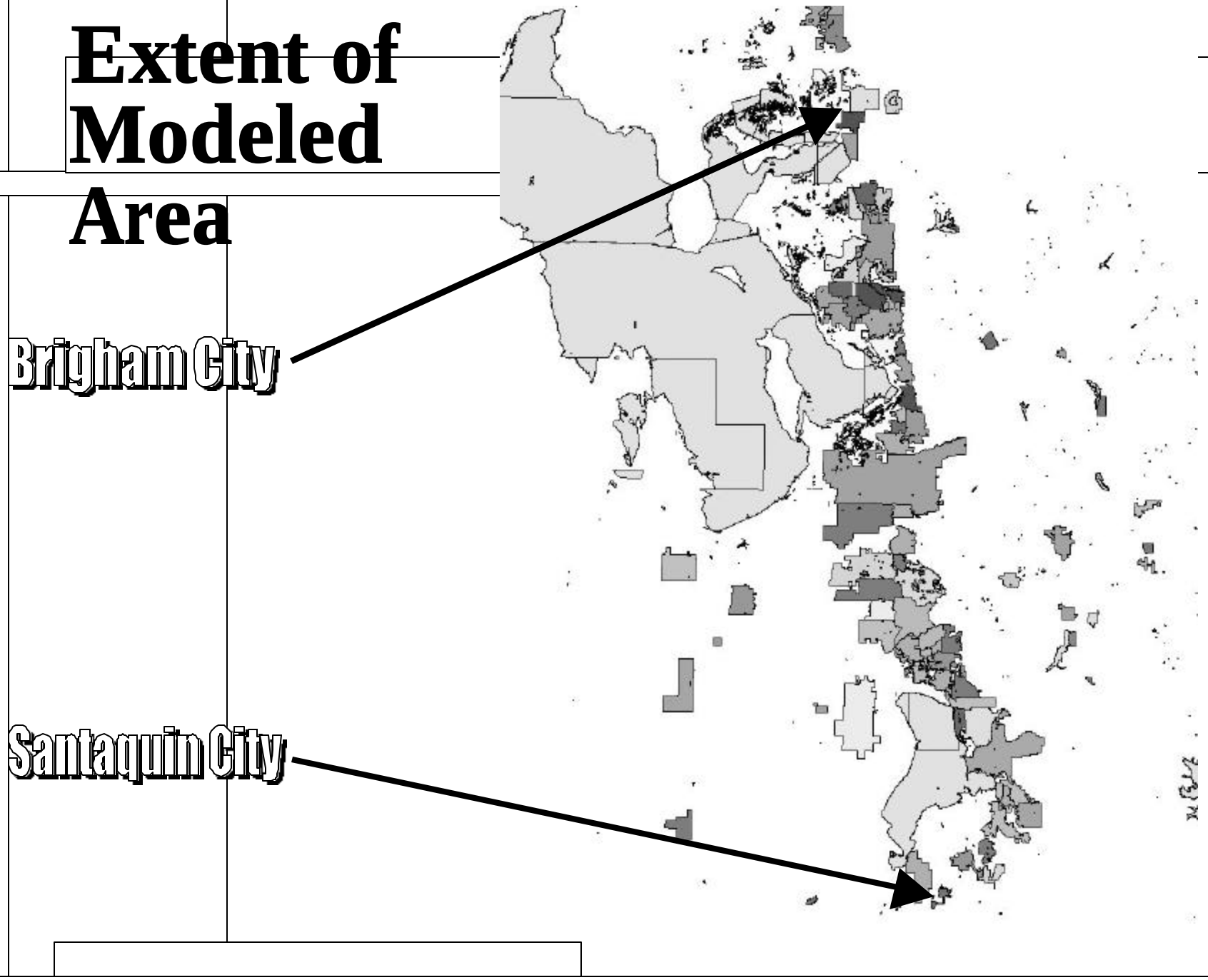
Introduction

- This presentation provides an overview of the integrated travel model currently under development for Mountainland Association of Governments and Wasatch Front Regional Council
- The model is being developed under contract with the firms of Michael Baker, Jr. and Urban Analytics

Project Goals

- Provide a better understanding of inter-regional commuting patterns through the Integration of the MAG and WFRC travel models
- Provide an integrated analytical model for the Inter-Regional Corridor Study

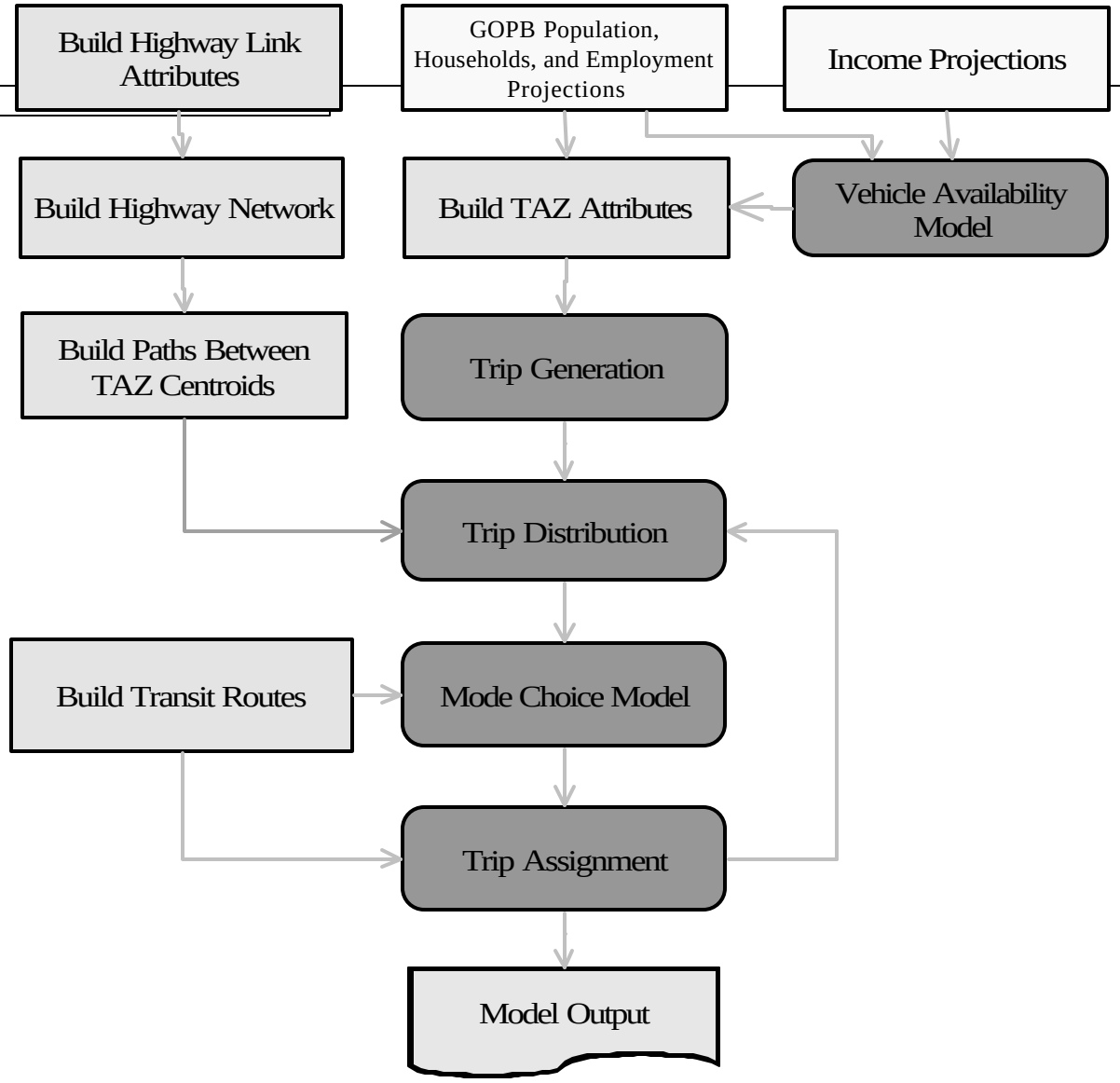
Extent of Modeled Area



Basic Model Assumptions

- Transportation: The movement of people, goods and information from one place to another.
- Basic Modeling Premise: Through the careful observation of people's existing travel behavior we can project those behavior patterns into future travel activity.

Inter-Regional Travel Model Flowchart



1993 Home Interview Survey

- Mountainland and the WFRC contracted with Applied Management & Planning Group in Los Angeles to conduct a home interview survey for their two MPOs.

	ALL CASES	WFRC	MAG
Number of Households	3,082	2,181	901
Number of People	8,333	5,654	2,679
Number of Activities	49,282	32,880	16,402
Number of Trips	40,949	27,226	13,723

Selected Demographics Per Household

	ALL CASES	WFRC	MAG
Household Size (All Ages)	3.14	2.99	3.51
Household Size (Age 5 and Older)	2.75	2.64	3.03
Vehicles per Household	1.97	1.95	2.01
Licensed Drivers per Household	1.93	1.89	2.05
Workers per Household	1.34	1.32	1.39
School-aged Children per Household	0.77	0.70	0.93
College Students per Household	0.25	0.20	0.36

Model Databases

- Socio-Economic Database (Traffic Analysis Zones)
  - Households stratified by persons per household and number of vehicles per household
  - Income per household
  - Employment
- Highway Database
  - Street and Highway link characteristics
- Transit Database
  - Transit routes classified by type of service

Vehicle Availability Model
Models Tested

Logit Model Formulation

$$Prob(n) = \frac{e^{U_x}}{\sum_{i=0}^{n_{\max}} e^{U_i}}$$

Where:

Prob(n) = the probability that households will own n vehicles (n=0,1,...n_{max})
e = the base of Naperian logarithms
nmax = the largest vehicle availability category
Un,Ui = the utility of owning “n” household vehicles

The utilities, U_n are defined as

$$U_n = b_{n0} + \sum_{j=1}^{n} b_{nj} X_{nj}$$

Where:

b_{n0} = a statistically estimated constant associated with having n vehicles
b_{nj} = a statistically estimated coefficient indicating the relative importance of variable X_{nj} on the utility of vehicle availability level n
X_{nj} = a variable specific to the the zone of residence

The 1992 Portland Logit Model

For zero-auto households:

$$U = -1.684 - 0.881 * HHSIZE - 1.452 * WRKRCL + 3.255 * INCOM1 + 1.942 * INCOM2 + 0.000220 * RET1M + 0.00001063 * TOTAL30T + 0.29095 * PEF$$

For one-auto households:

$$U = 1.497 - 0.720 * HHSIZE - 1.065 * WRKRCL + 2.259 * INCOM1 + 1.944 * INCOM2 + 1.033 * INCOM3 + 0.000132 * RET1M + 0.00000615 * TOTAL30T + 0.0902 * PEF$$

For two-auto households:

$$U = 1.619 - 0.141 * HHSIZE - 0.660 * WRKRCL + 0.377 * INCOM1 + 0.555 * INCOM2 + 0.0478 * INCOM3 + 0.000060 * RET1M + 0.00000334 * TOTAL30T + 0.0337 * PEF$$

For three-or-more-auto households:

$$U = 0$$

Where:

U(n)	= Utility
HHSIZE	= Number of persons in zone/segment
WORKERCL	= Number of workers in zone/segment
INCOMn	= Dummy variable equal to one if the avg. household income level is n
RET1M	= Number of retail employees within 1 mile
TOTAL30T	= Number of employees within 30 minutes of travel time via the transit mode
PEF	= Pedestrian environment factor

Modeled vs. Observed

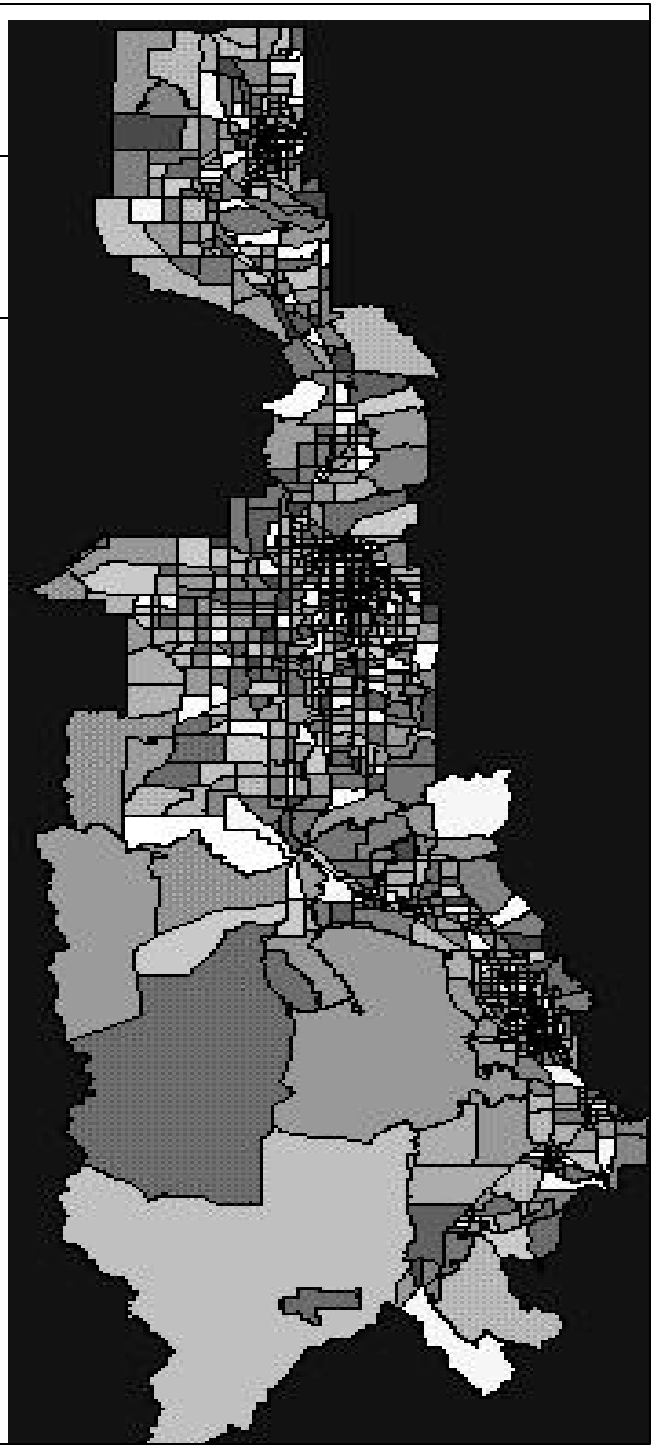
Vehicle Availability by Household Size

Model Percent - Observed Percent

HHSIZE	0	1	2	3+
1	-0.09%	2.29%	-2.79%	0.59%
2	2.18%	7.59%	-6.15%	-3.63%
3	-1.54%	-2.84%	9.75%	-5.37%
4	-0.16%	-1.70%	5.00%	-3.14%
5	-0.19%	-2.21%	-3.33%	5.73%
6	-0.91%	-6.94%	-6.70%	14.55%

Traffic Analysis Zones

- TAZ attributes are compiled for each model year.
- Non-motorized travel attributes are also summarized by TAZ



Highway Database

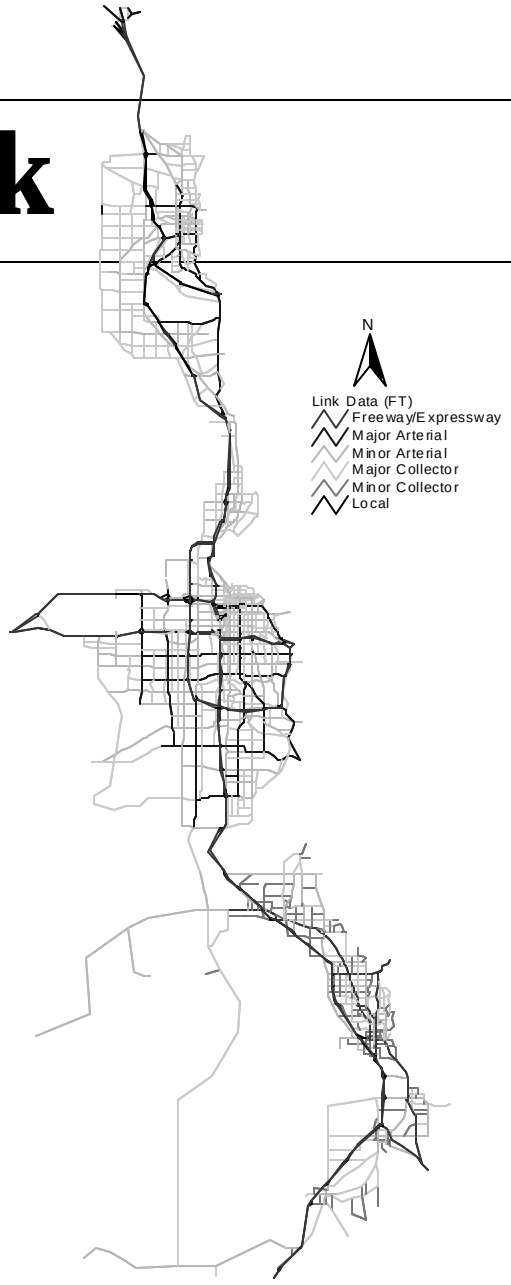
- Links and Nodes
  - **Nodes** are point locations that define the end points of links.
  - **Centroids** are specialized nodes representing the center of activity in a TAZ.
  - **Links** are straight line representations of streets segments or corridors selected to be included in the highway network.
    - Link distance
    - Speed
    - Number of lanes
    - Capacity per lane
    - Functional classification

Transit Database

- Routes
  - Type of service
    - Local
    - Premium
      - Express bus
      - Light rail
      - Commuter rail
  - Frequency of service

Build Highway Network

- The 1996 network shown on the right is color coded by functional classification.



Build Paths Between TAZ Centroids

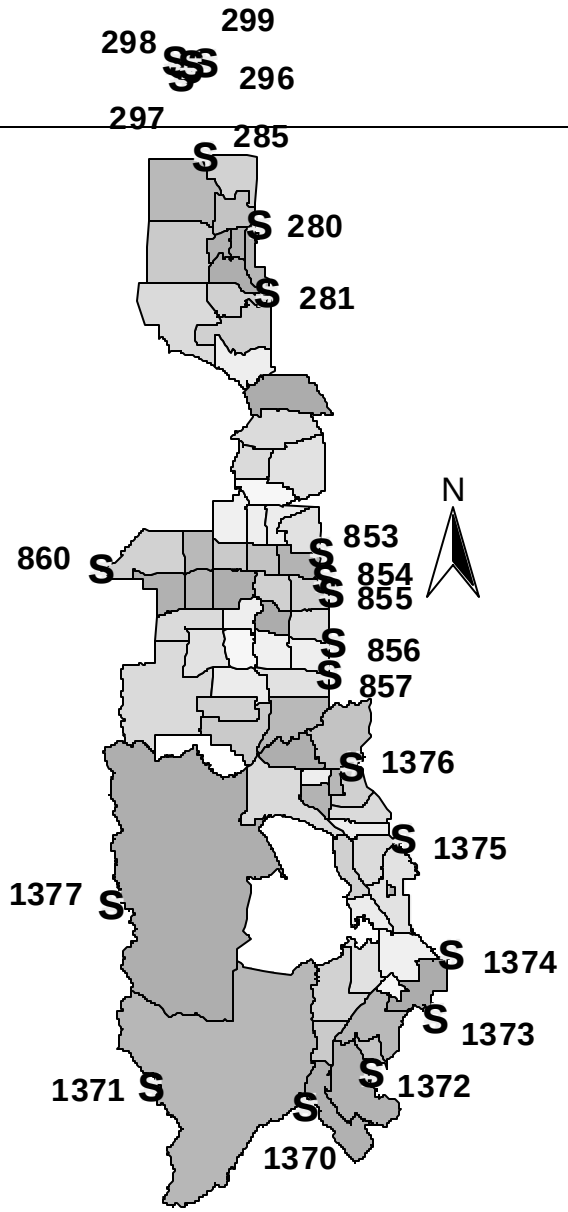
- A set of “best” paths are determined by the model from each TAZ centroid to every other TAZ centroid in the network.
- “Best” is determined by a series of options available through the model.

Trip Generation

- The trip generation model calculates the number of trip productions and attractions produced by each TAZ by trip type.
  - Home-based work trips
  - Home-based school trips (college)
  - Home-based other trips
  - Non-home-based trips
- It also handles external-to-external, internal-to-external, and external-to-internal trips.

Internal-External Travel

The yellow circles represent External Stations where traffic enters and leaves the modeled area.



Trip Generation Summary

Trip Purpose	1996 Productions	Attractions
Home-Based Work	888,624	1,006,275
Home-Based Other	3,673,930	3,753,656
Non-Home Based	2,034,712	2,034,712
Internal-External	161,041	176,728
Commercial	563,293	567,692
TOTAL	7,321,600	7,539,063

Trip Distribution

Trip Distribution Continued

- Impedance
  - Function of Time and Distance

$$\text{Impedance} = (a \bullet \text{Time}) + (b \bullet \text{Distance})$$

where α and β are constants

  - Testing various combinations of constants to achieve best trip distribution model performance

Trip Distribution Continued

- Home Interview Survey
  - Used to calibrate trip distribution model(s)
  - Observed trip length frequencies (TLF) derived by purpose, peak/off-peak
  - Steps
    - Error Checking
    - Trip Linking (17.2% HBW; 54.8% HBO; 28.0% NHB)
    - Derive observed (obs.) TLFs

Trip Distribution Continued

- Intra-Zonal Travel Time

$$IZ = \frac{[0.5 \times \text{SQRT}(\text{Zone Area}) \times 60]}{\text{Speed}(\text{Area Type})}$$

- Friction Factors
  - Initial factors based on “default” values provided by gamma function form:

$$F_{ij} = e^{a} t^{b} e^{ct}$$

where a,b, and c vary by trip purpose

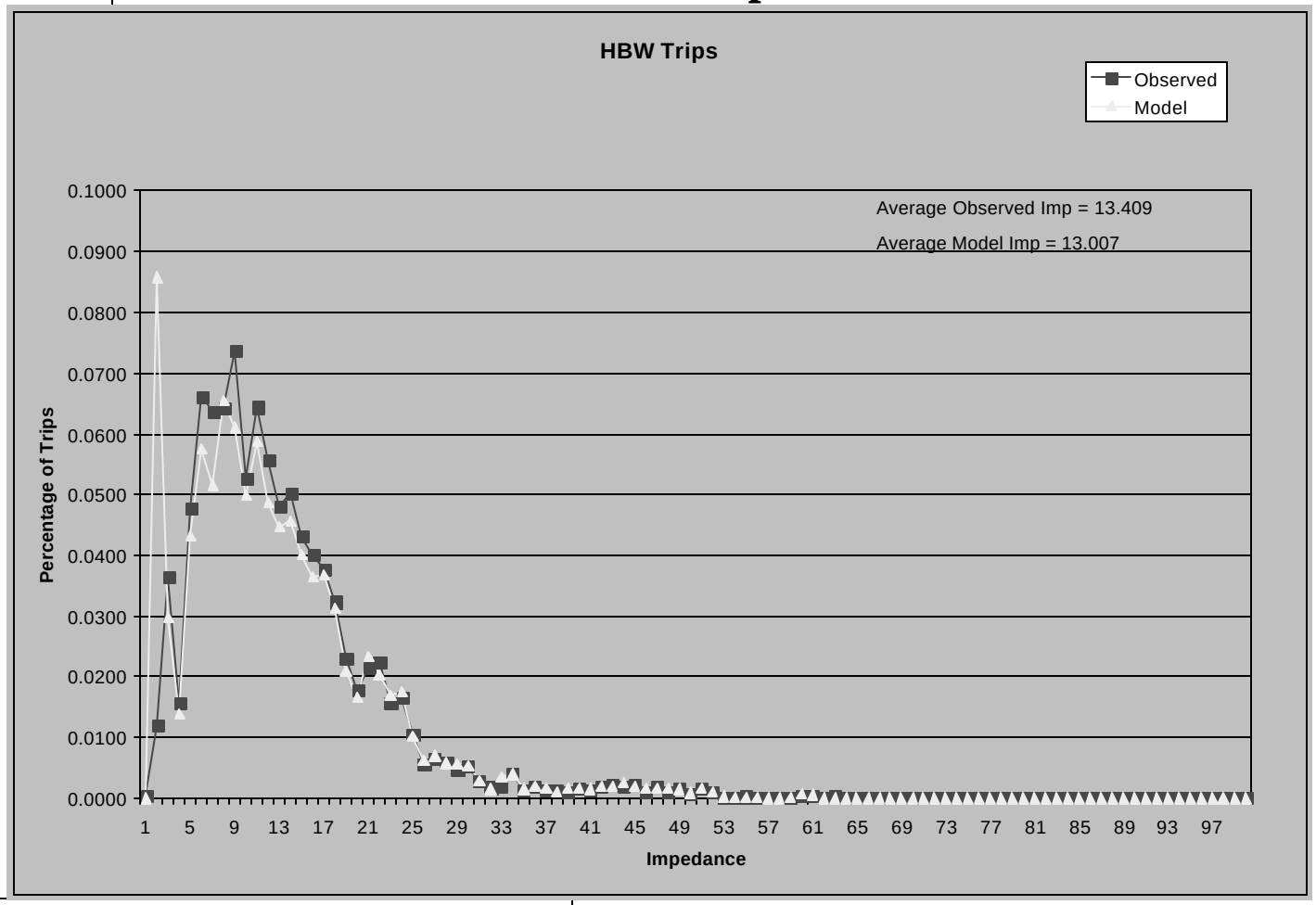
Trip Distribution Continued

- Calibration Process
  - Initial Friction Factors
  - Gravity Model to calculate TLF
  - Update Friction Factors as a function of difference between obs. TLF and calculated value
  - Gravity Model to yield updated TLF
  - Compare to observed
    - Similar Shape
    - Avg. TLF; +/- 3% of obs. TLF
  - Iterate process as necessary

Calibration Results

Home-Based Work

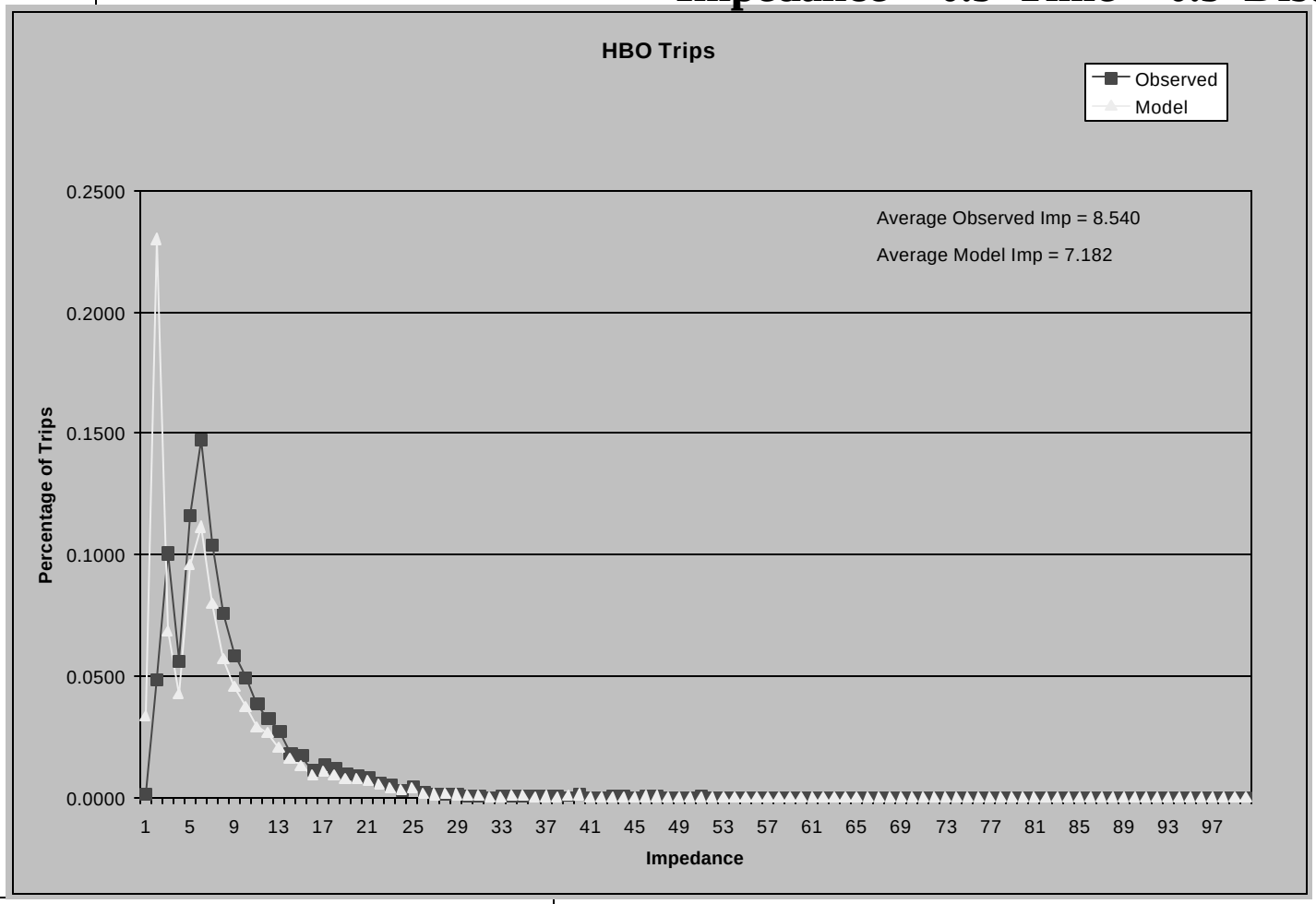
Impedance = 0.5*Time + 0.5*Distance



Calibration Results

Home-Based Other

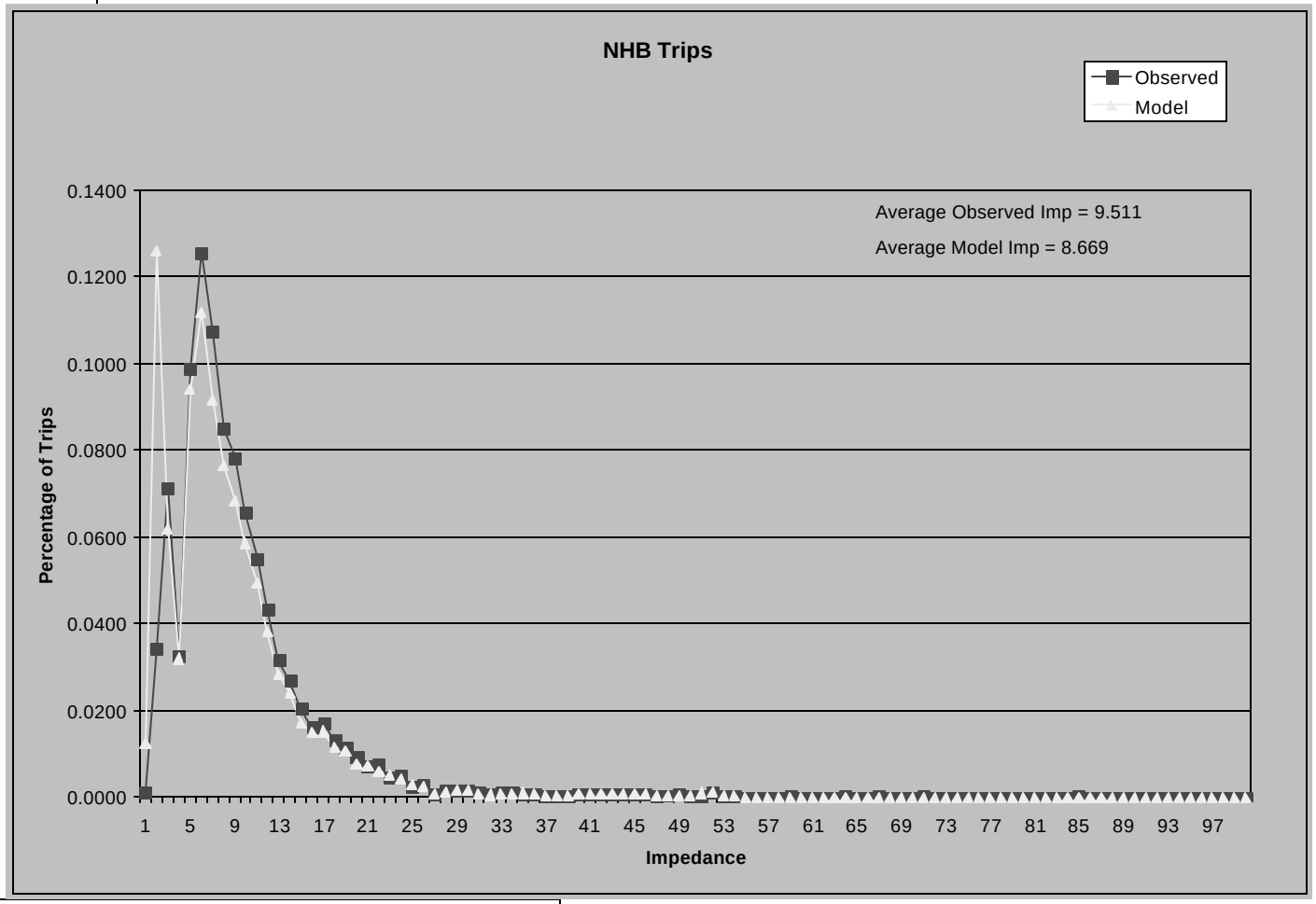
Impedance = 0.5*Time + 0.5*Distance



Calibration Results

Non-Home Based

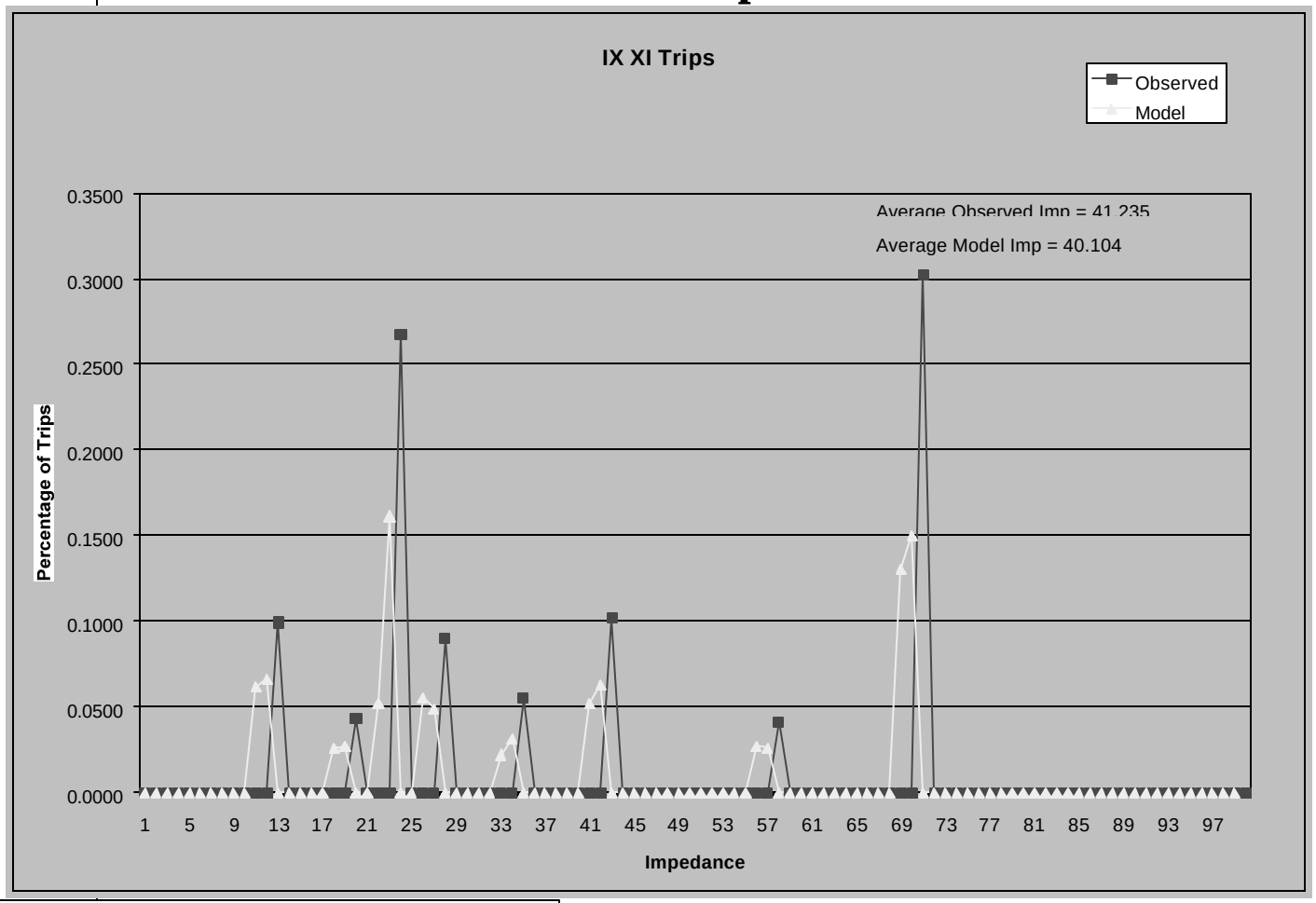
Impedance = 0.5*Time + 0.5*Distance



Calibration Results

Internal-External

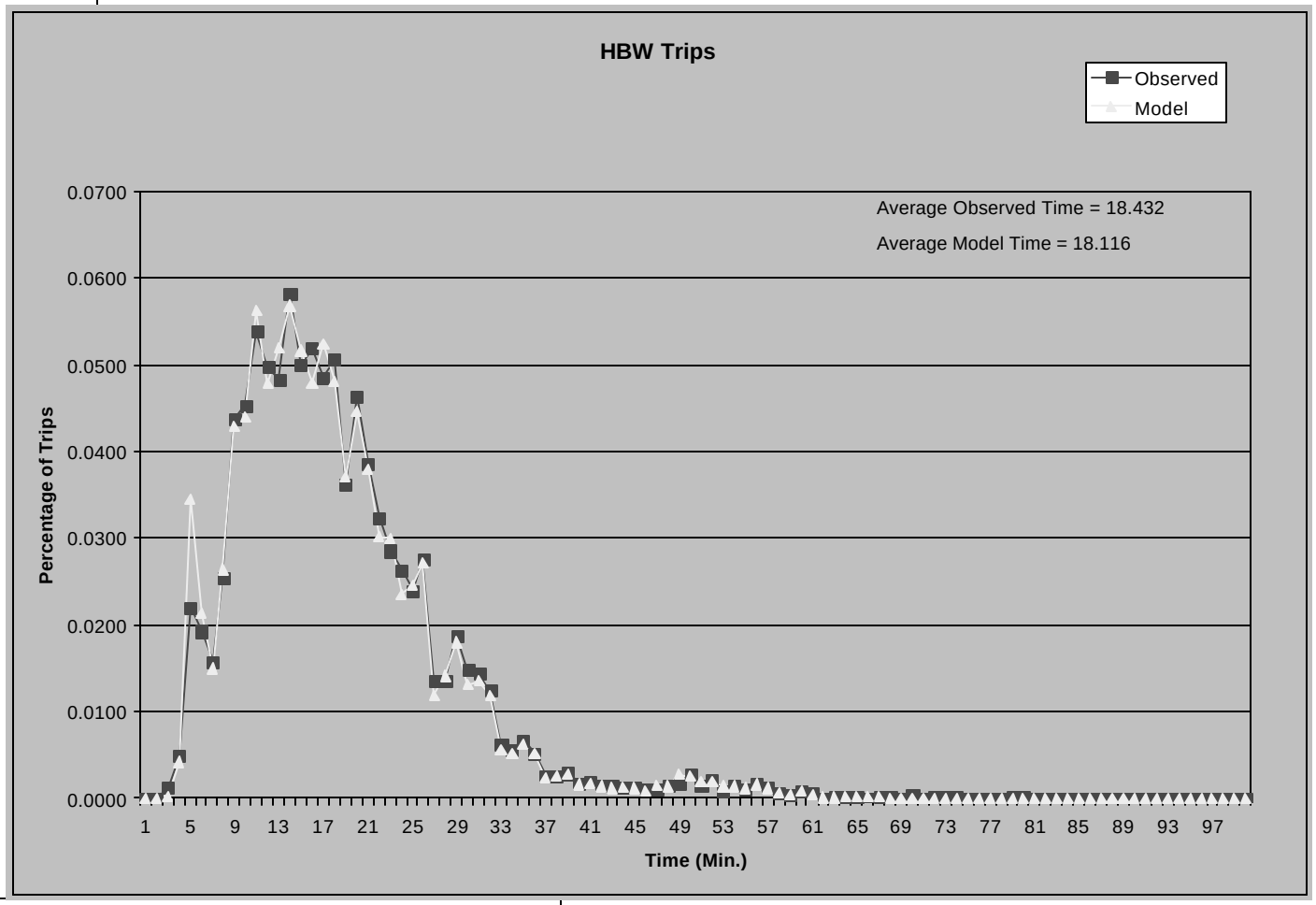
Impedance = 0.5*Time + 0.5*Distance



Calibration Results

Home-Based Work

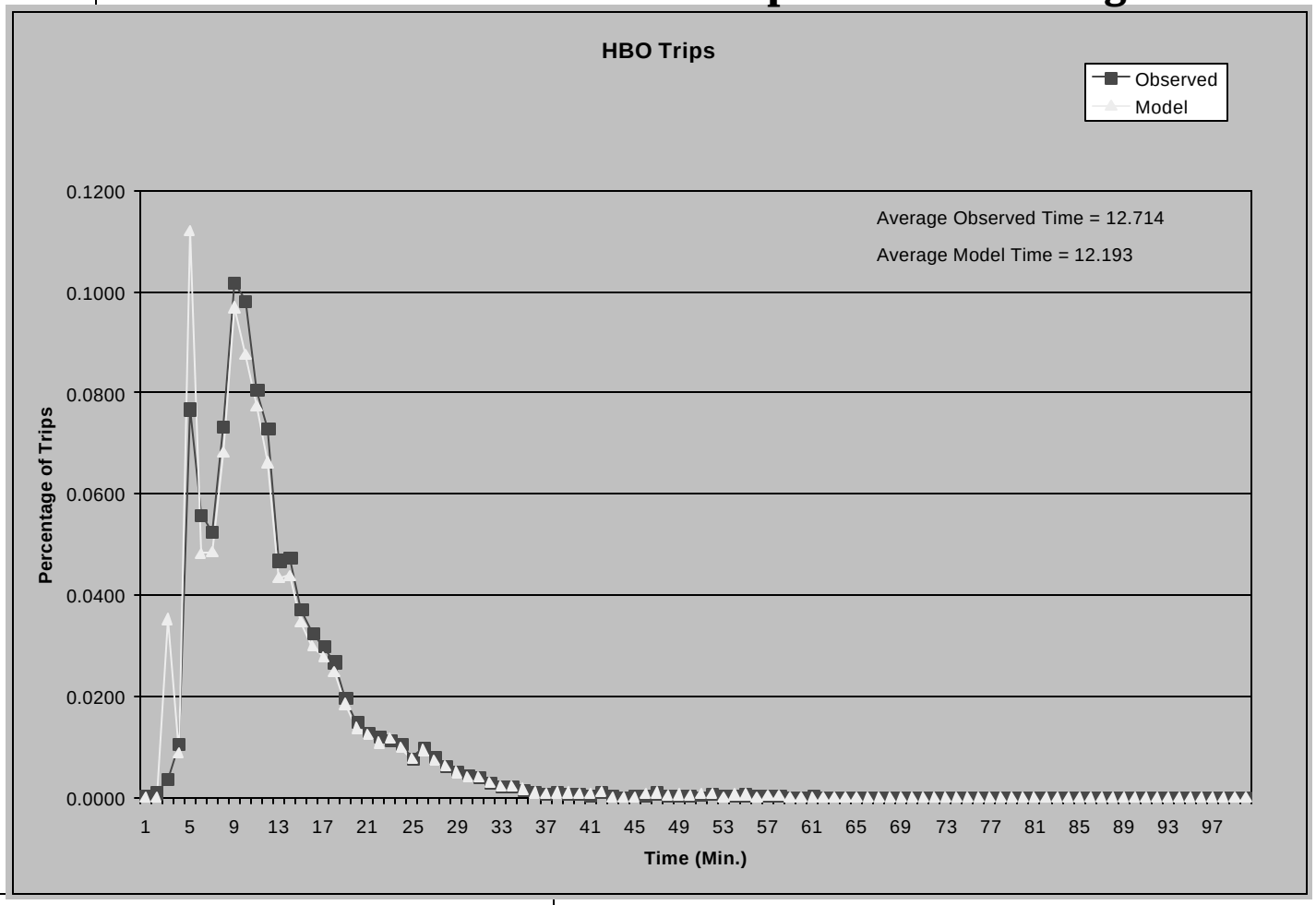
Impedance = Uncongested Travel Time



Calibration Results

Home-Based Other

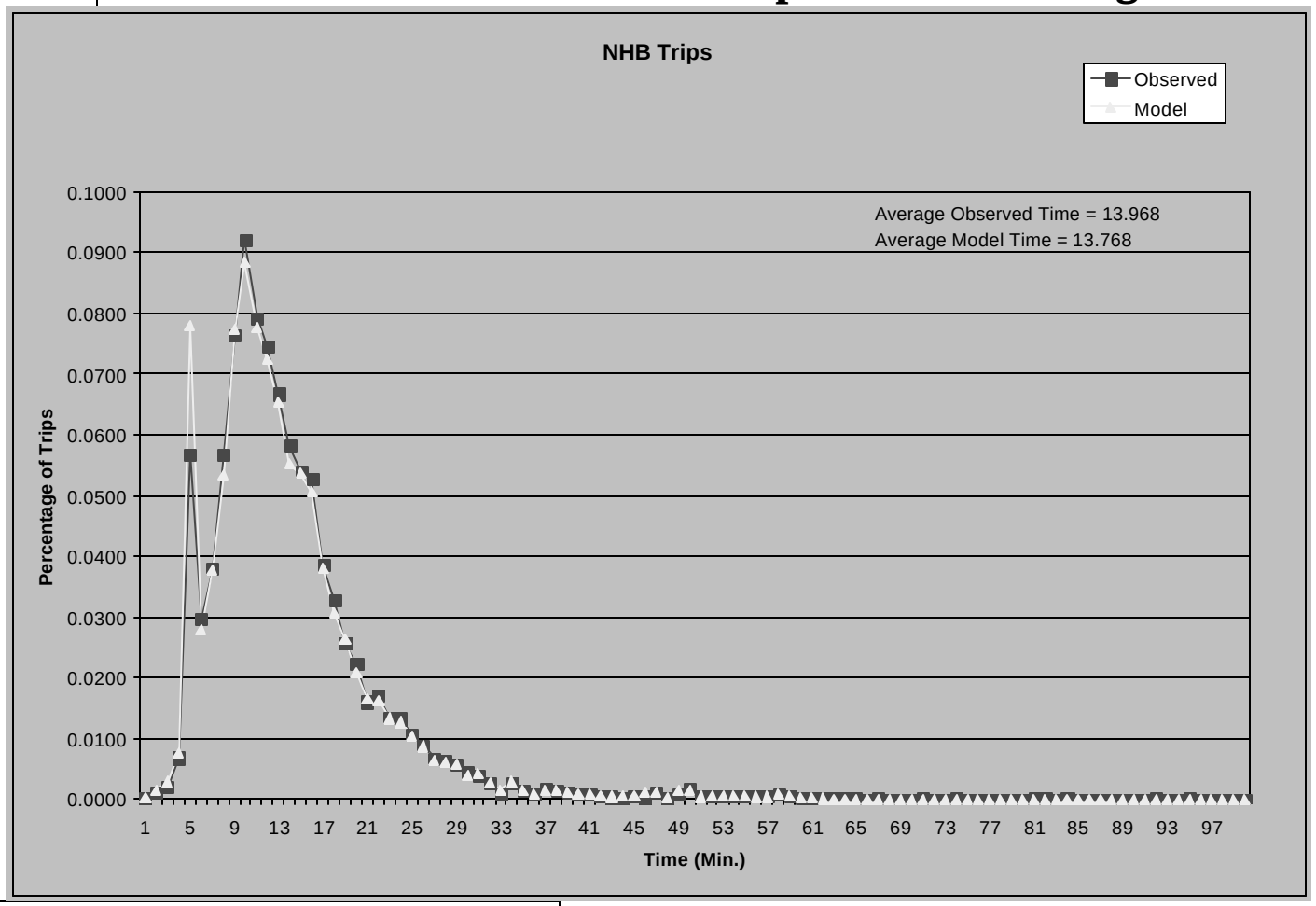
Impedance = Uncongested Travel Time



Calibration Results

Non-Home Bases

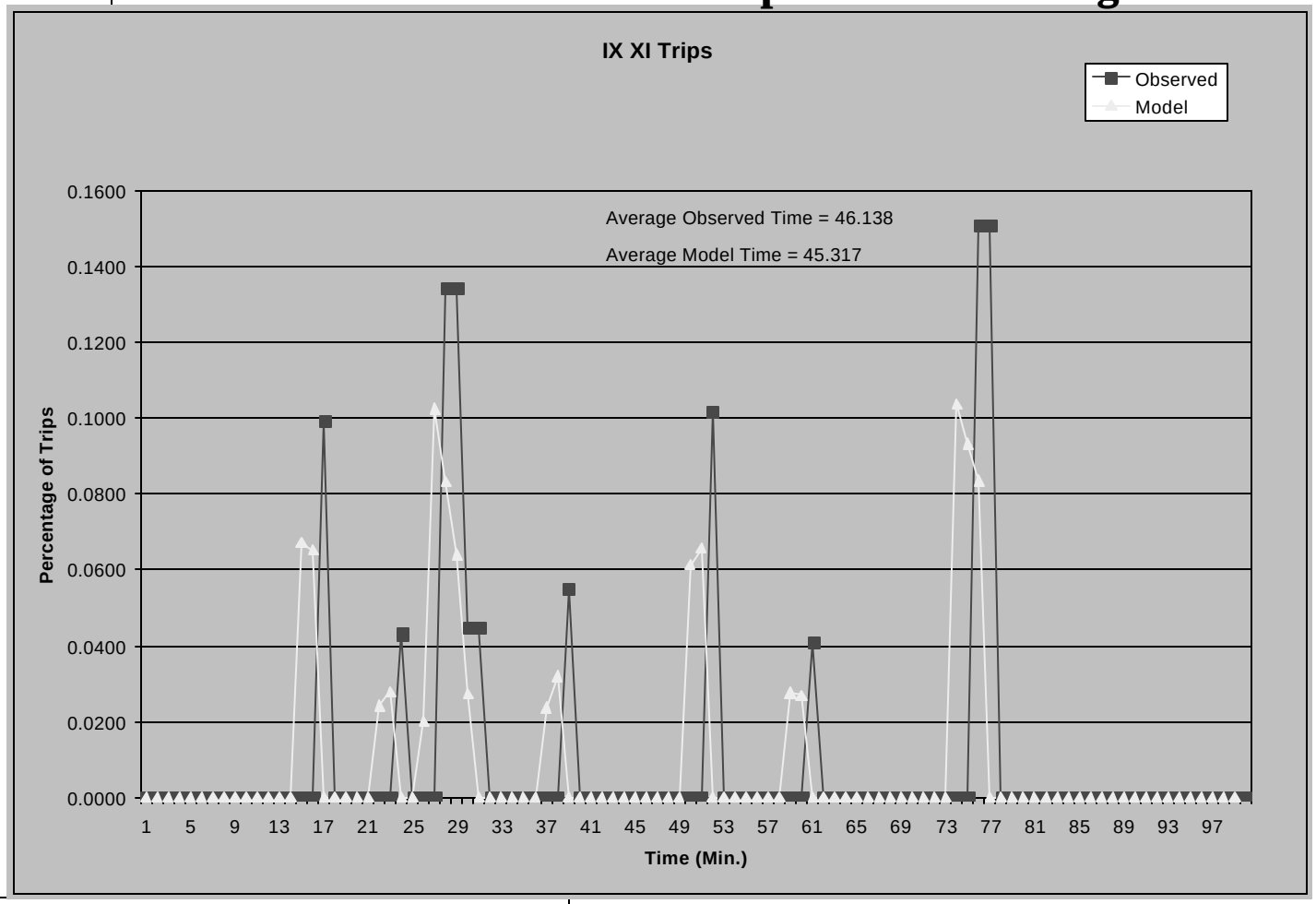
Impedance = Uncongested Travel Time



Calibration Results

Internal-External

Impedance = Uncongested Travel Time



Trip Length Frequency Calibration Summary

Impedance = 0.5*Time + 0.5*Distance

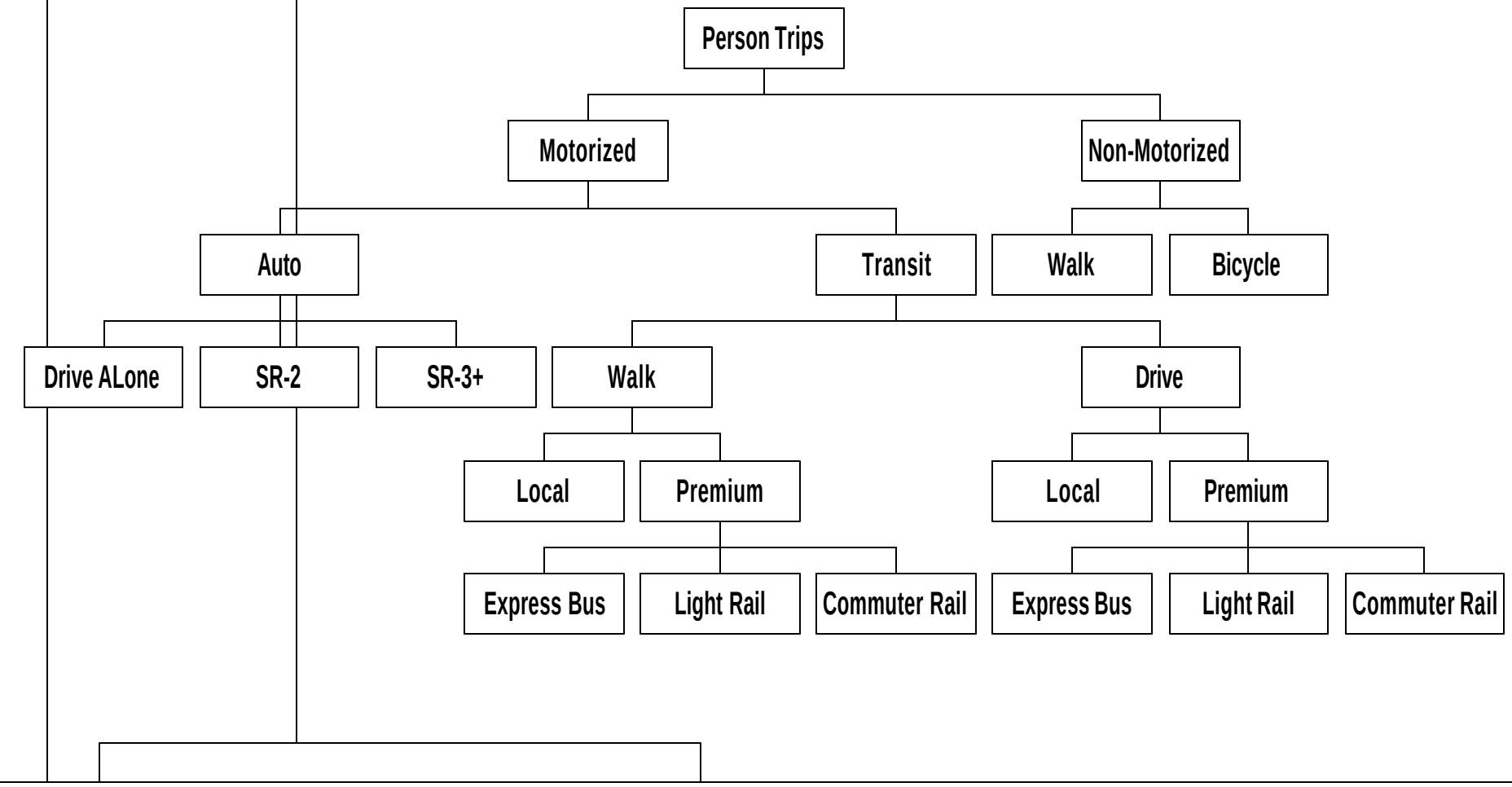
Trip Purpose	Observed	Modeled	Deviation
Home-Based Work	13.41	13.01	-2.98%
Home-Based Other	8.54	7.18	-15.93%
Non-Home Based	9.51	8.67	-8.83%
Internal-External	41.23	40.1	-2.74%

Impedance = Uncongested Time (min.)

Trip Purpose	Observed	Modeled	
Home-Based Work	18.43	18.12	-1.68%
Home-Based Other	12.71	12.19	-4.09%
Non-Home Based	13.97	13.77	-1.43%
Internal-External	46.14	45.32	-1.78%

Mode Choice Model

Enhanced HBW Mode Choice Model Structure



Proposed HBW Non-Motorized Model

- Based on Sacramento's Mode Choice Model
- Use of Transportation, Household, and Land Use/Urban Form Variables
- Applied to Four Strata of Households Determined by Number of Workers and Auto Availability
- Use of Pedestrian Environmental Factors (PEF), Consistent with the Auto Ownership Model

1993 Non-Motorized Observed Trips HBW

Household Category	Walk	Bike
1. **No Autos**	**3,400**	**260**
2. Workers> Autos	**2,430**	**3,860**
3. Single-worker, min. 1 auto / worker	**7,610**	**2,100**
4. Multi-worker, min. 1 auto / worker	**9,840**	**2,470**
TOTAL	23, 280	8,690

Other Observed Data

- CTPP Regional Mode and Sub-Mode Shares
- College Person Trip Table
- College Observed Trips and Shares

Trip Assignment

Trip Assignment Continued

- Trip assignment allocates the trips from the mode choice model to each of the links along the “Best” paths between the TAZ centroids.
- Output impedence information is then fed back to the trip distribution model and the process is run again and again until the model reaches “convergence”.